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16. ABSTRACT

Representatives of the New Jersey Department of Health's Asbestos Control Service conducted final clearance evaluations at 79 schools where asbestos removal took place during the Summer of 1987. The evaluations entailed a thorough visual inspection of each abatement area by an experienced inspector, the performance of aggressive air sampling, and sample analysis by transmission electron microscopy (Yamate-revised Metnod). Each abatement site was evaluated against an absolute air clearance criterion of 0.01 fiber per cubic centimeter (f/cm^3). The results of this study support the premise that a thorough visual inspection strongly influences passing a transmission electron microscopy (TEM) clearance test. These data also demonstrate that post abatement air concentrations that meet the clearance criterion (0.01 f/cm^3) can be achieved by a detailed cleaning, thorough visual inspection, and subsequent use of aggressive air sampling techniques.

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ACHIEVING A TRANSMISSION ELECTRON MICROSCOPY CLEARANCE CRITERION AT ASBESTOS ABATEMENT SITES IN NEW JERSEY

Abstract

Representatives of the New Jersey Department of Health's Asbestos Control Service conducted final clearance evaluations at 79 schools where asbestos removal took place during the Summer of 1987. The evaluations entailed a thorough visual inspection of each abatement area by an experienced inspector, the performance of aggressive air sampling, and sample analysis by transmission electron microscopy (Yamate-revised Method). Each abatement site was evaluated against an absolute air clearance criterion of 0.01 fiber per cubic centimeter (f/cm^3). The results of this study support the premise that a thorough visual inspection strongly influences passing a transmission electron microscopy (TEM) clearance test. These data also demonstrate that post abatement air concentrations that meet the clearance criterion (0.01 f/cm^3) can be achieved by a detailed cleaning, thorough visual inspection, and subsequent use of aggressive air sampling techniques.

Introduction

During the Summer of 1987, the New Jersey Department of Health's Asbestos Control Service (ACS) conducted final clearance evaluations at 79 schools where asbestos had been removed from student and teacher occupied areas, (i.e., classrooms, offices, and cafeterias). These evaluations were conducted as part of the State of New Jersey's "Summer '87 Quality Assurance Program."

The Quality Assurance Program's primary objectives were 1) to determine whether asbestos abatement and attendant cleaning procedures had been properly completed, and 2) to ensure that post abatement air monitoring met the TEM clearance criterion of <0.01 f/cm^3.

This paper discusses the final clearance evaluations at the 79 schools and summarizes observations, problems encountered, and recommendations for attaining successful transmission electron microscopy (TEM) clearance.

Final Clearance Evaluations

The final clearance evaluations involved a thorough visual inspection of each abatement area and aggressive air sampling by an experienced inspector.

Visual Inspection

The initial visual inspections were performed by the Asbestos Safety Technician (AST) who monitored the abatement process throughout the entire project. Upon completion of their preliminary visual inspections, the technicians in-turn contacted the Asbestos Control Service (ACS) for a final visual inspection.

An ACS inspector conducted final visual inspections of every accessible space of each removal project to determine whether the remedial actions had been properly completed. The Asbestos Control Service's visual inspection was designed to identify any incomplete removal work and to detect obvious signs of inadequate cleaning of the work site. Only the visual inspection data collected by the ACS inspector were soley used in this study.

The ACS inspector first visually examined all substrate surfaces to ensure that no asbestos-containing material (ACM) remained. Special attention was given to pipes, structural members, and irregular surfaces having corners and hard-to-reach areas. If any quantity of ACM was found to remain, the site failed the visual inspection and additional removal was conducted before another visual inspection was initiated.

The ACS inspector then determined if the work site had been adequately cleaned. All surfaces were examined for dust and debris, especially overhead areas (such as tops of suspended light fixtures) and areas under stationary fixtures. One of the following techniques was used in the examination of surfaces to establish that a "no-dust" criterion had been met:

- Use of a damp cloth to collect dust from the surface and then inspecting the cloth for evidence of dust.

- Darkening of the remediated room and shining of a flashlight so that the light beam just glances any smooth horizontal or vertical surface. A gloved finger is then run across the illuminated area; if a line is left on the surface, dust is still present.

If either of these techniques showed that dust still remained, the ACS inspector then recommended that the entire work area be recleaned before the area could be reinspected.

Air Sampling

Air Sampling Strategy

After the site passed the visual inspection, the ACS inspector collected post-abatement air samples utilizing aggressive sampling (using a leaf blower) techniques before critical containment barriers were removed. A minimum of one air sample per 10,000 square feet of floor space was collected. If several rooms were involved, a check was made to assure the work site was homogeneous (i.e., if contiguous areas had the same type of ACM and the same type of abatement process was performed).

The samplers were positioned within the homogeneous work sites so as to collect representative samples. A random number procedure was used for room selection. Each room was assigned a unique two-digit number. A random number table was then consulted for sequences of two-digit numbers. The first three room numbers to appear in selected sequence constituted the air test samples location.

During the postabatement monitoring, the personal protective equipment worn by the ACS inspectors included a one-piece outer protective garment consisting of a zippered overall with hood and draw string, elastic cuffs, and closure boots. The outer garment material consisted of spunbonded tyvek. Respiratory protection consisted of a powered air purifying respirator.

Before air monitoring began, floors, walls, and ceilings were swept with the exhaust of a 1-horsepower leaf blower to accomplish aggressive sampling. Particular attention was paid to areas where "dead air conditions could be present." Subsequently, stationary fans were placed at a height of 2 meters in locations that would not interfere with air monitoring equipment. The fan air was directed at the ceiling and operated at a low speed. One fan was used for each 10,000 cubic feet of the work site and operated for the duration of the sampling period.

Air Sampling and Analytical Methodology

The air samples were collected on 25-mm, 0.4-µm pore-size Nuclepore polycarbonate filters contained in a three-piece cassette. The filter cassette was positioned at approximately a 45-degree angle and located 4 to 5 feet (about 1.5 meters) above the floor. Immediately before sampling, the face cap was removed to expose the full face of the filter to the air stream. The filter assembly was attached to an electric-powered vacuum pump. An in-line calibrated rotameter was used to regulate the air-flow rate through the filter assembly at approximately 10 liters per minute (L/min). The air samples were collected long enough to achieve an air volume of 2000 to 4000 liters. At the end of the sampling period, filters were turned upright and the vacuum pump turned off before they were disconnected from the vacuum pump. The filters were stored in an upright position for transport to the laboratory.

The polycarbonate filters were prepared and analyzed for asbestos fibers by TEM in accordance with the revised Yamate Method. Sample analyses were performed by the Public Health and Environmental Laboratories, New Jersey Department of Health (NJDOH) in Trenton, New Jersey, and a laboratory under contract. The contract laboratory operated in accordance with the Quality Assurance procedures of the NJDOH, Public Health, and Environmental Laboratories.

Results and Discussion

Final Clearance Evaluations

Final clearance evaluations were completed at 79 schools where abatement had taken place. The abatement projects involved removal of spray- and trowel-applied fireproofing on ceilings or structural members and thermal insulation on pipes.

From one to six visual inspections were conducted per abatement site. Figure 1 shows the percentage of sites that passed the visual inspection per given attempt. The largest percentage of sites passed the visual inspection on the first and second attempts, 42.2 percent and 40.3 percent, respectively. The cumulative percentages of sites passing the visual inspection were 82.5 percent at the completion of the first and second attempts and approximately 97 percent at the third visual inspection.

The number of TEM clearance attempts conducted per abatement site ranged from one to three. A site was retested if a sample showed an airborne asbestos concentration of >0.01 f/cm^3. Figure 2 shows the percentage of sites passing TEM clearance per given attempt. Approximately 97 percent of the sites passed TEM clearance on the first attempt after passing a thorough visual inspection. Only 3.1 percent of the sites failed TEM clearance after passing a thorough visual inspection.

Figure 3 integrates the percentage of sites passing TEM clearance with the total number of visual inspections and clearance TEM attempts. As shown in Figure 3, the largest percentage of sites (96.9 percent) passed TEM clearance on the first attempt; a small percentage of sites required a second and third TEM clearance test, 2.9 percent and 0.2 percent, respectively. These data support the premise that effective removal that meets the standards of a thorough visual inspection strongly influences passing a TEM clearance test.

Table 1 presents the descriptive statistics of the samples that passed the TEM clearance test and those that failed. In all, 598 samples were collected; 573 samples (95.8 percent) showed airborne asbestos concentrations of <0.01 f/cm^3, and 25

Figure 1. Percentage of Sites Passing Visual Inspection

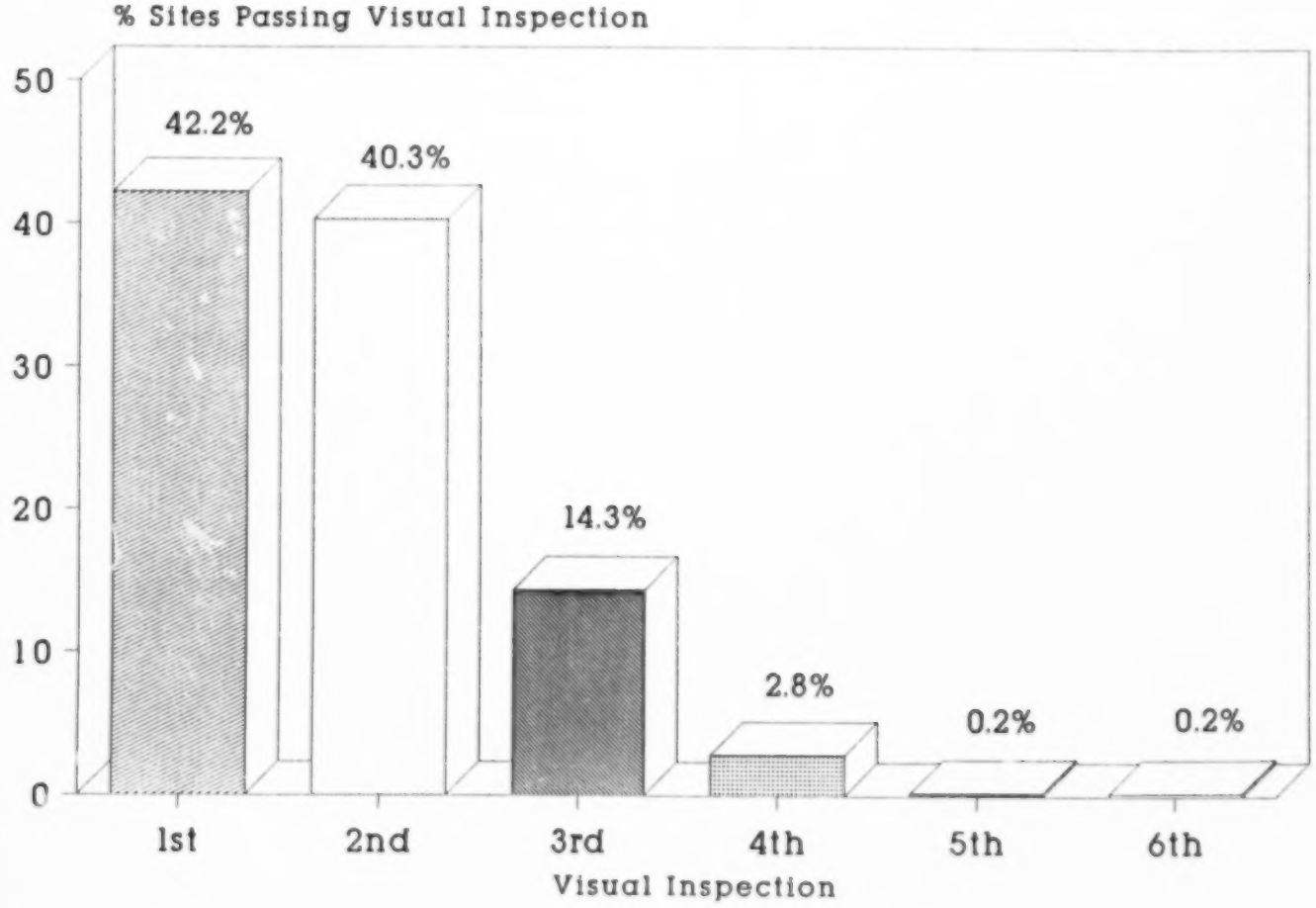


Figure 2. Percentage of Sites Passing TEM Clearance for Each Clearance Test

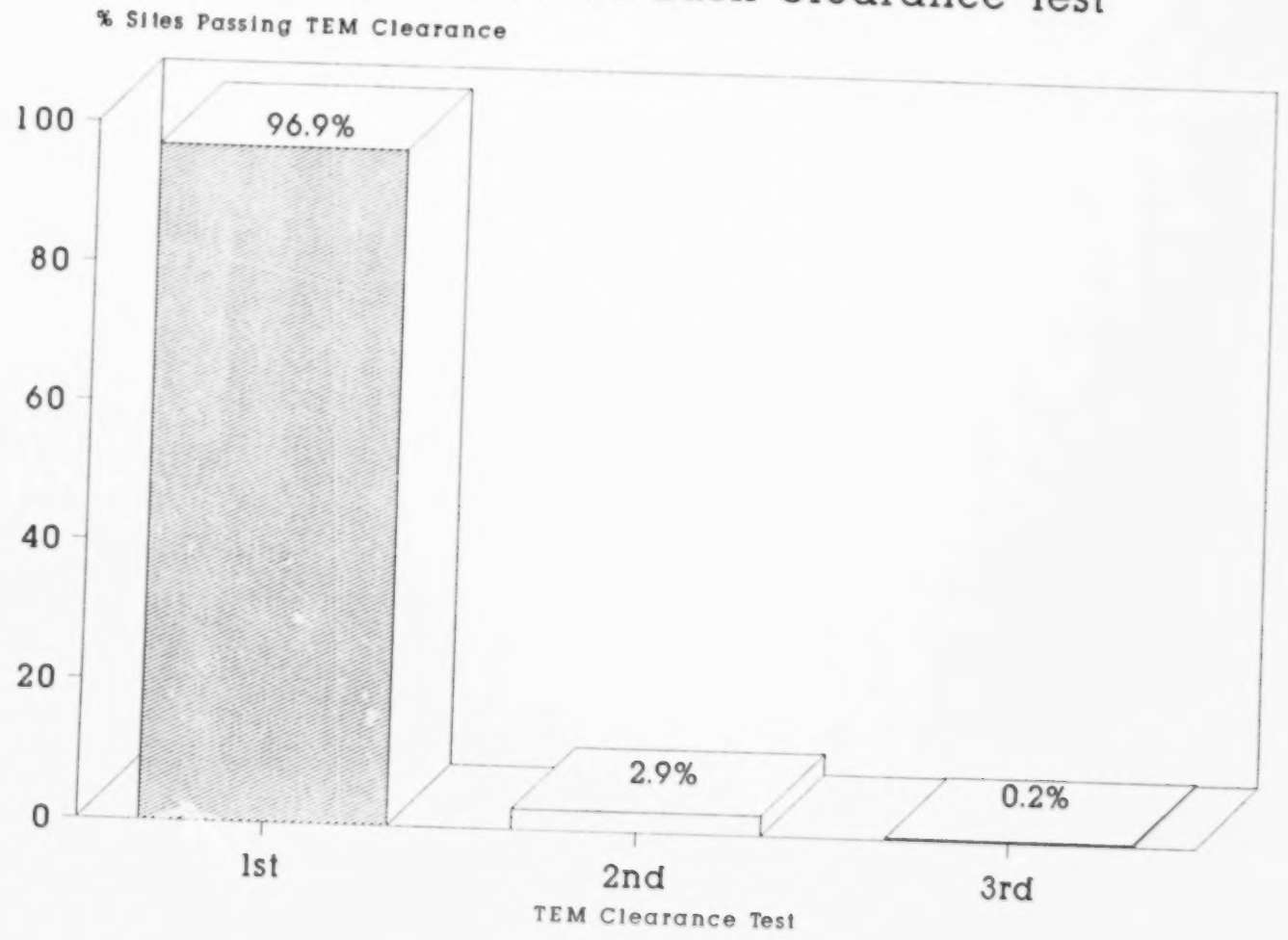
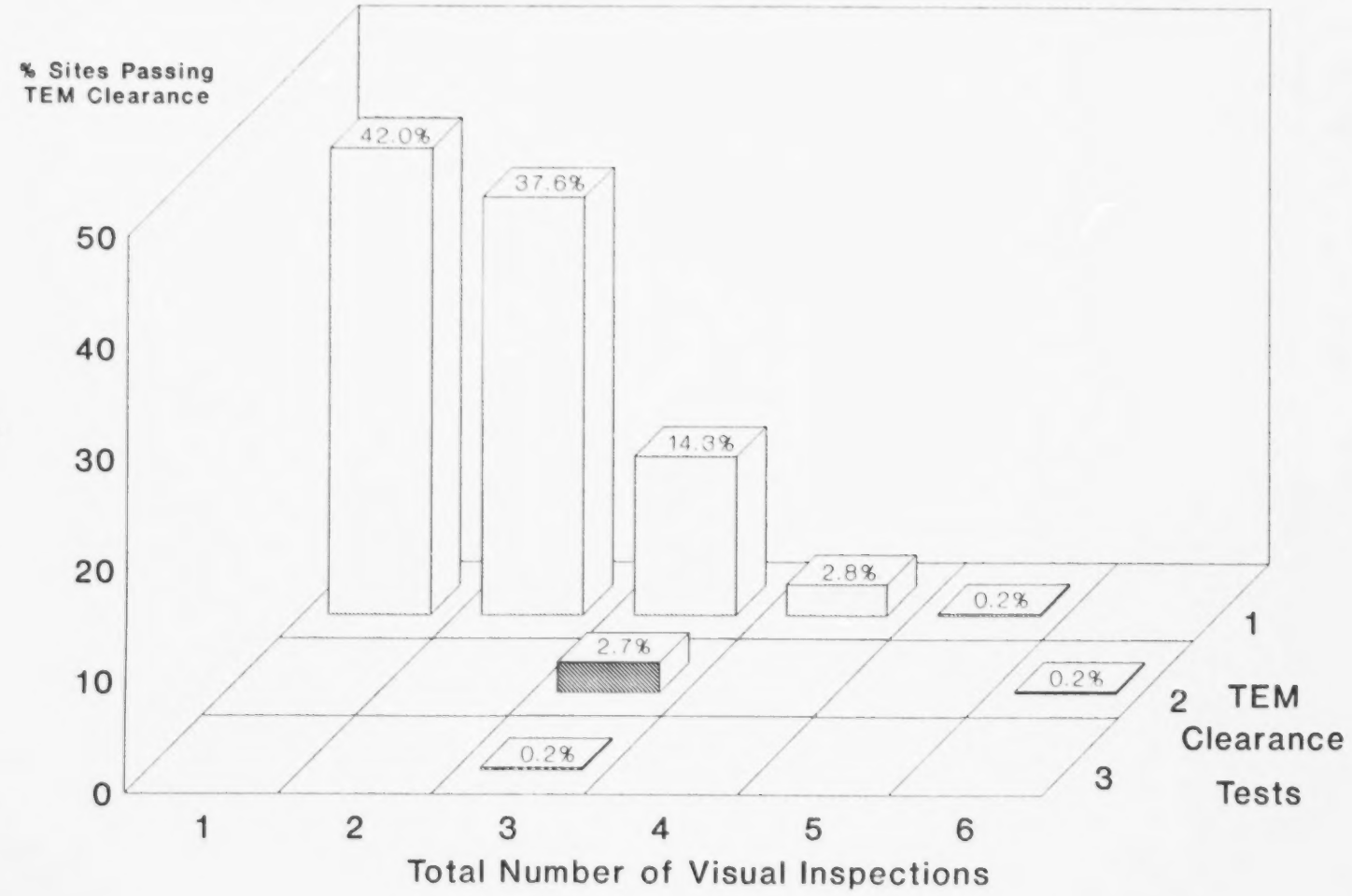


Figure 3. Percentage of Sites Passing TEM Clearance by Total Number of Visual Inspections and Clearance Tests



samples (4.2 percent) showed concentrations of >0.01 f/cm^3. The arithmetic mean concentrations were 0.0019 f/cm^3 for the samples that passed the clearance test criterion (<0.01 f/cm^3) and 0.0304 f/cm^3 for those that failed. These data unequivocally demonstrate that post abatement air concentrations (using TEM and aggressive sampling techniques) of 0.01 f/cm^3 can be achieved.

TABLE 1. DESCRIPTIVE STATISTICS FOR AIRBORNE ASBESTOS CONCENTRATIONS (f/cm^3) MEASURED AT 79 SCHOOLS

TEM decision	n/N*	Arithmetic mean	Std. dev.	Coef. Var.	Range	Median
Passed	234/573†	0.00196	0.0019	0.98	0.0002-0.0021	0.001
Failed	25/25	0.0304	0.0298	0.98	0.0110-0.1130	0.0160

* n/N denotes the number of samples with concentrations above the detection limit/total number of samples analyzed.

† Statistics calculated on 234 samples. The 339 samples showing concentrations below the limit of detection were not included.

Observations and Problems in Asbestos Abatement Practices

In general, abatement sites failed final clearance evaluations due to 1) poor working relationship between the AST's and contractors; 2) incomplete job specifications; 3) inadequate cleanup procedures; and 4) the lack of a detailed final visual inspection.

The following is a summary of observations made and common problems encountered during the Summer 1987 abatement projects. Based on our experiences, we believe many of these problems can be easily resolved or avoided altogether. Well-designed specifications, good work practices, cooperation between the parties involved, and the establishment of common, well-understood goals are all essential

components of successful abatement projects that we found lacking in some projects. These items are discussed briefly in the following two subsections.

Asbestos Safety Technician/Abatement Contractor Relationship

A working relationship should be established between the Asbestos Safety Technician (AST) and the abatement contractor at the beginning of each abatement project. Specific objectives should be clearly defined, and complete adherence to all work practices outlined in Subchapter 8 (N.J.A.C. 5:23-8) must be agreed upon. In New Jersey, the AST is technically responsible for this; however, the full cooperation of the contractor is essential. Achievement of a successful relationship requires optimum communication between the two parties. Problems such as language barriers, ethnic background, or age differences should be dealt with and resolved at the outset.

Problems with Job Specifications

Job specifications are often incomplete or too generic, often leading to confusion as to where a contractor's responsibilities end and to disagreement over whether a job has been completed according to contract. Such basic misunderstandings tend to result in unaddressed asbestos material within a work zone or in an improperly abated area. It is important that the scope of the work specify that all dust debris be cleaned from the area, regardless of whether it was caused by the abatement procedures. In the case of glove-bag removal, this area should not be limited to the immediate vicinity, but should reasonably extend to surrounding areas. In the event of a partial removal, remaining asbestos material should be sealed in a manner that prevents fibers from being released into the abatement area. In short, specifications and the scope of work should be well designed and all-inclusive and should include allowances for additional or unforeseen circumstances.

Final Cleanup Procedures

Final cleaning must be detailed and thorough. It is recommended that the contractor appoint a detail crew to address residual material that has been overlooked after "final" cleaning has been performed. This reinspection should be conducted in an organized and meticulous fashion. Each specific area should be "cleared" visually before moving on to the next area. Our experience has shown that this type of detailed cleaning is often not utilized because of insufficient manpower, resulting from contractors overextending themselves in accepting abatement projects.

Aggressive Cleaning

After final cleaning and before wet mopping, a leaf blower should be used to stir up and dislodge finer particles from crevices and other hard-to-reach areas. This material should then be given a few hours to settle before the final wet mopping is performed. It is important that all negative-air filtration units remain on during cleaning procedures and through the 24-hour drying period. This aggressive technique is also helpful in removal of residual surfacing material prior to encapsulation.

Final Visual Inspections

The AST should conduct a detailed inspection of all areas. This comprehensive and thorough inspection requires that the AST be meticulous, aggressive, and conscientious. Particular attention should be paid to problem areas--e.g., along conduit lines, in and around light fixtures, along ceiling/wall junctions, and hard-to-reach areas. Ladders, flashlights, and pocketknives are important equipment to complete a proper visual inspection. The same technique used by the contractor's detail cleaning crew should be applied during the final visual inspection. The AST must proceed in an organized fashion, must not be afraid to double-check, and should "clear" each area before moving on to the next.

Conclusions

- The use of detailed and thorough final cleaning procedures will greatly increase passing of visual inspections.
- If an area passes a thorough visual inspection, then it is highly likely that it will also pass a TEM clearance test.
- Postabatement airborne asbestos concentrations of <0.01 f/cm^3 by TEM (aggressive sampling) were achieved.
- Well-designed abatement specifications, good work practices and procedures, and a cooperative relationship between the asbestos safety technician and abatement contractor are essential to achieving a safe and successful asbestos abatement project.

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